DEC STD 176-3 Printed-Wiring Board Acceptance Criteria for SMOBC (Soldermask Over Bare Copper) Product

DOCUMENT IDENTIFIER: A-DS-EL00176-03-0000 Rev D, 11-Nov-1992

ABSTRACT: This standard specifies end-product criteria for Soldermask Over Bare Copper (SMOBC) rigid printed-wiring boards (PWBs) that have been fabricated or purchased by Digital Equipment Corporation.

APPLICABILITY: It is mandatory that, whether fabricated in Digital manufacturing facilities or purchased from qualified suppliers, all PWBs meet or exceed all applicable specifications defined in this standard, unless modified by applicable Digital engineering drawings and specifications.

STATUS: APPROVED 11-Nov-1992; use VTX SMC for current status.

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1 INTRODUCTION

This standard specifies end product criteria for Soldermask Over Bare Copper (SMOBC) rigid printed-wiring boards (PWBs) that have been fabricated or purchased by Digital Equipment Corporation.

1.1 SCOPE

This standard specifies the final end product acceptance criteria for SMOBC rigid printed-wiring boards of the types and technology codes specified in *DEC STD 176-0 Printed Wiring-Board Acceptance Criteria*, Table 1. This standard is intended to augment information presented in DEC STD 176-0 where final end product criteria for SMOBC differs from conventional plated tin-lead/reflowed printed-wiring boards. This standard does not apply to flex circuits or ceramic printed-wiring substrates.

1.2 RESPONSIBILITIES

This section describes specific responsibilities of persons or organizations for fulfilling the requirements of this standard.

1.2.1 Digital Organizations

All internal organizations involved in the fabrication, procurement, and use of PWBs are responsible for understanding and complying to the requirements in this document and for providing information to keep the document up-to-date.

1.2.2 Suppliers

Suppliers under contract to produce PWBs for Digital must comply with the requirements of this standard.

1.2.3 PWB Standards Committee

Refer to EL-SM176-00, *Printed-Wiring Board Manual*, for a list of committee members.

2 GENERAL REQUIREMENTS

Whether fabricated in Digital manufacturing facilities or purchased from qualified suppliers, all PWBs shall meet or exceed all applicable specifications defined in this standard, as modified only by applicable Digital drawings and specifications.

2.1 TERMINOLOGY

The definitions of all printed-wiring terms used in this standard shall be as specified in *DEC STD 016-0 Printed-Wiring Board and Module Manufacturing Terminology*.

2.2 COMPOSITION AND PROCESSING

The composition and processing of the types of PWBs covered by this standard shall be as described in DEC STD 016-0.

2.3 MICROSECTIONING AND MAGNIFICATION

Microsection inspections shall be performed in accordance with subhead 2.1.1 of IPC-TM-650, *Test Methods Manual*. The appropriate minimum magnification is specified in Table 1. Higher magnification may be used to verify conformance to this standard's visual and functional requirements. Defects found at higher magnification are considered defects.

Table 1: Magnification

Minimum Item(s) Inspected	Magnification (X)
Overall cosmetic quality	Visual inspection
Board features	2
Referee inspection of board features	10
Plating quality in microsections	200
Plating and soldermask thickness in microsections	400

2.4 ROUNDING CONVENTION

See DEC STD 176-0, subhead 2.5.

2.5 FABRICATION MATERIALS

Fabrication materials are specified in DEC STD 176-0. For informational purposes, the following material requirements for soldermask and plating materials are provided.

2.5.1 Soldermask

The soldermask shall be a permanent polymer coating or photopolymer film that will prevent solder bridging during component assembly operations. Soldermask shall:

a. Conform to the latest revisions of IPC-SM-840, *Qualification and Performance of Permanent Polymer Coating (Soldermask) for Class II Printed Wiring Boards*

b. Be recognized by Underwriters Laboratories (UL) according to *DEC STD 176-2 Printed-Wiring Board Product Safety Criteria*

c. Conform to the requirements of text under heading 6 of this standard

d. Conform to EL-MF543-00, *Procedure for Soldermask Evaluation*

2.5.2 Plating Materials

The following plating materials, or approved functional equivalents, are acceptable for Digital PWBs. Plating thicknesses are specified under subheads 3.2 and 4.1 of this standard.

a. Electroless copper—A suitable electroless (chemical) copper deposition material adherent to plastic and copper must be used in a preliminary process that provides a conductive layer over nonconductive base materials, prior to the electroplating of plated-through holes.

b. Electrolytic copper—All electrolytically deposited copper plating shall conform to MIL-C-14550, *Copper Plating, Electrodeposited, Class 1*, and have a minimum purity of 99.5% as determined by ASTM E53-48, *Standard Method for Chemical Analysis of Copper (Electrolytic Determination)*.

c. Solder coating—SMOBC technology requires the use of a solder coating process (as opposed to a plated tin-lead). The solder and equipment used must be controlled in conformance with the requirements of Federal Specification QQ-S-571, *Solder, Tin Alloy: Tin-Lead Alloy; and Lead Alloy*, with composition of either SN63 (preferred) or SN60.

d. Electrolytic nickel—All electrolytically deposited nickel plating shall be low stress and conform to Federal Specification QQ-N-290, *Nickel Plating, Electrodeposited, Class 2*.

e. Electrolytic gold—Gold electroplating shall conform to MIL-G-45204, *Gold Plating, Electrodeposited, Type II, Grade C*. The electroplating must also be uniform in quality and have a purity of 99%.

2.6 WORKMANSHIP AND CLEANLINESS

There shall be no contaminations or imperfections that affect form, fit, function, reliability, serviceability, or processability within a module application.

Ionic (electrical) contaminants shall not exceed the amounts specified in DEC STD 176-0, subhead 2.7.

2.7 IDENTIFICATION MARKINGS

Digital and supplier PWB identification markings are specified in DEC STD 176-0.

2.8 COLORS

All PWBs shall be fabricated in the colors normally produced by processing the fabrication materials specified in DEC STD 176-0, and in subhead 2.6 of this standard.

Regardless of the colors used and the degree of discoloration, the manufacturer's name or trademark and the Digital part identifier (part number and revision) must be legible.

3 PLATED-THROUGH HOLES (PTH)

Requirements are specified in the following subheads for PTH diameters and plating thicknesses.

3.1 PLATED HOLE DIAMETERS

For nonsurface mount products, PTH diameters and tolerances must conform to DEC STD 176-0, Table 8. For surface mount products, PTH diameters and tolerances must conform to *DEC STD 176-4 Surface Mount Printed-Wiring Board Acceptance Criteria*.

3.2 PLATING THICKNESSES

Copper plating thickness for nonsurface mount products must conform to DEC STD 176-0. Copper plating thickness for surface mount products must conform to DEC STD 176-4.

The solder coating in the hole shall have a minimum thickness of 0.000150 inch (0.00381 mm) at the crest and uniform solder coverage (no exposed copper or copper/tin intermetallics) at the knee of the hole. Minor indentations from test probes at the hole edge are acceptable. Tented vias do not require solder coating.

NOTE

For any surface feature, the crest is defined as the highest solder thickness location. This may not necessarily be at the geometric center of the feature.

3.3 OTHER PLATED-THROUGH HOLE CHARACTERISTICS

Plated-through hole quality/reliability characteristics for SMOBC products must conform to DEC STD 176-0.

4 CONDUCTORS AND PADS

For SMOBC products, solder protrusions (for example, projections, icicles) extending beyond the pad diameter greater than the minimum spacing of the nearest adjacent surface feature are not allowed.

Additional requirements for conductor widths/spacings, pad diameters, annular rings, edge characteristics, and other characteristics are specified in DEC STD 176-0. For informational purposes, conductor plating thicknesses are as follows.

4.1 PLATING THICKNESSES

As determined via microsectioning and appropriate magnification (refer to text under subhead 2.3), the minimum conductor and pad plating thicknesses at the crest shall be as specified in Table 2, unless specified otherwise.

Table 2: Plating Thickness

Plating Material	Minimum Thickness
Electroless copper	Sufficient for subsequent copper electroplating
Electrolytic copper	0.001 inch (0.025 mm)
Solder coating	0.000150 inch (0.00381 mm) at crest for lines or pads not covered by soldermask. Total solder coverage at pad/hole edge. Total coverage on conductor/pad side wall preferred but not required.

5 SURFACE SOLDER-COATING CHARACTERISTICS

This section describes surface solder-coating characteristics.

5.1 SOLDER COATING

All nonterminal areas of surface power/ground planes, circuit-external thief areas, and large etch widths should be covered with soldermask. For non surface mount products, all nonterminal areas of surface power/ground planes, circuit-external thief areas, and large etch widths not covered with soldermask may exhibit an irregular surface profile (an appearance of puddling), unless specified otherwise. For Surface Mount Technology (SMT) products, puddling is allowed subject to the requirements in DEC STD 176-4 subhead 9, Soldermask Spacing/Coverage Requirements, and Figure 3.

The solder coated surfaces shall exhibit alloy composition of 50% to 70% tin, and 30% to 50% lead. The solder coating shall be 0.00015 inch (0.0038 mm) thick minimum when measured at the crest. Total solder coverage at the conductor, pad, and hole edge is required. Exposed copper or copper-tin intermetallics is not allowed. Total coverage of conductor/pad side wall (where applicable) is preferred but not required.

NOTE

For any surface feature, the crest is defined as the highest solder thickness location. This may not necessarily be at the geometric center of the feature due to the solder-leveling process.

5.2 ADHESION

When PWBs are inspected for plating/solder-coating adhesion using the tape test described in the latest revision of IPC-TM-650, no parts of the conductive pattern, including outgrowth, shall be removed from the boards.

5.3 SOLDERABILITY

Holes and terminal areas that will be soldered shall demonstrate at least 95% wetting with 5% unconcentrated dewetting and pinholing allowed. There shall be no dewetting, pinholing, or any solderability related defects allowed for surface mount pads. All nonterminal areas of surface power/ground planes and large etch widths not covered with soldermask may be dewetted.

Solderability tests shall be in accordance with IPC-S-804, *Solderability Test Methods for Printed Wiring Boards*. Regardless of the test method used, the following shall occur.

a. Proper wetting of the surface, hole wall, and terminal area.

b. No blistering, delamination (lifted conductors) or other forms of degradation of the conductive pattern.

6 SOLDERMASK

Soldermask shall cover conductors to prevent bridging during the module solder process.

Soldermask types, placement, thickness, cure, solvent/flux resistance, flammability, abrasion resistance, adhesion, soldering requirements, and other characteristics are specified in DEC STD 176-0, and modified for SMOBC (where applicable) in the following subheads.

6.1 TYPES

A full soldermask, as described in DEC STD 176-0, shall cover the outside surface of all PWBs as specified below. All dry film soldermask shall be applied with a vacuum lamination process. Dry film soldermask thicknesses of 0.003 inch (0.076 mm) and 0.004 inch (0.102 mm) may be used on non SMT SMOBC products. For SMT products refer to DEC STD 176-4.

6.2 PLACEMENT

Soldermask placement and spacing requirements are specified in the following sections.

6.2.1 Board Side

SMOBC boards require full soldermask placed according to DEC STD 176-0 requirements.

6.2.2 Spacing/Coverage Requirements

Soldermask spacing requirements for SMOBC products are as follows.

a. Wet process soldermask shall extend over both sides of the conductor or pad to the base laminate.

b. Dry film and/or wet photoimageable soldermask coverage shall be as follows.

   Conductor-to-Conductor—All metal must be completely encapsulated with a minimum 0.001 inch (0.025 mm) foot to the base laminate.

   Conductor-to-Pad—The conductor metal must be completely encapsulated with a minimum 0.001 inch (0.025 mm) foot to the base laminate.

   Pad-to-Pad—Provided that pad-to-pad spacing meets or exceeds minimum soldermask spacing requirements, adjacent pads without conductors between them do not require dry film soldermask to the base laminate. Adjacent pads with spacing below minimum require dry film soldermask with a minimum 0.001 inch (0.025 mm) foot to the base laminate.

c. On all PWBs, the soldermask shall not be closer than 0.002 inch (0.051 mm) to component holes, evidenced by a 0.002 (0.051 mm) annular ring of solder coating on pad surface.

d. Certain noncomponent holes/pads are selected by design to have a reduced soldermask clearance pad size equal to the finished-hole size. This pad size is intended to cover (not "tent") the pad with soldermask and thus prevent solder fill during wave solder. Since this clearance pad diameter is equal to the finished-hole size, it is acceptable if there is soldermask or solder inside the PTH hole wall only for these special noncomponent holes. Exposed copper on pads and PTH barrel is acceptable for this type hole.

6.3 CURE

The soldermask shall not exhibit tackiness, blistering, delamination, or color change when tested under controlled laboratory conditions as specified in IPC-SM-840. Also refer to subhead 6.8 of this document.

6.4 SOLVENT AND FLUX RESISTANCE

The soldermask shall not exhibit a degradation in surface characteristics, such as surface roughness, tackiness, blistering or color change, when tested under controlled laboratory conditions as specified in IPC-SM-840.

6.5 FLAMMABILITY

The soldermask material must meet all UL requirements as specified in DEC STD 176-2.

6.6 ABRASION RESISTANCE

When tested in accordance with IPC-TM-650, the soldermask shall not be scratched by a pencil softer than an F hardness.

6.7 ADHESION

Adhesion conformance is to be determined using the tape test described below. Conductor areas larger than 0.050 inch (1.27 mm) do not require tape testing.

1. Ensure that the board is clean and dry.
2. Obtain a strip of 0.50 inch (12.7 mm) adhesive tape equal to the length of the board and conforming to Federal Specification A-A-113 (formerly L-T-90 *Tape, Pressure-Sensitive Adhesive (Cellophane and Cellulose Acetate), Type II, Class B* (for example 3M brand #800 tape).
3. In an area where the conductor/line density is the highest, press the tape down tightly along the length of the board, ensuring that any air pockets are pressed out.
4. With a sharp pull perpendicular to the pattern, rapidly remove the tape from the board.
5. There shall be no evidence of any soldermask peel.

6.8 SOLDER RESISTANCE

For solder resistance determination on nonsurface mount products, refer to DEC STD 176-0. For solder resistance on surface mount products, refer to DEC STD 176-4.

6.9 OTHER SOLDERMASK CHARACTERISTICS

Other soldermask characteristics include blistering, voids, exposed conductors, and placement defects.

6.9.1 Blistering

Blistering is not acceptable.

6.9.2 Scratches, Pinholes, Voids

For SMOBC boards, all bare copper circuitry must be covered with soldermask. Exposed laminate is acceptable.

Pinholes and voids in the soldermask prior to solder coating that result in exposed conductors *exhibiting solder-coated etch* are acceptable provided there is no exposed adjacent metal within 0.015 inch (0.38 mm).

For soldermask defects that result in exposed copper, refer to DEC STD 176-0, subhead 9.9.4.

6.9.3 Placement Defects

Soldermask is acceptable in slots, notches, and cutouts if it does not reduce their dimensions below specification. Soldermask on fingers is acceptable provided it does not extend into the minimum gold plating area.

7 AUTOTHIEVING

Autothieving is a process that adds current density sinks (nonfunctional plating areas) to a printed-wiring board during imaging. When autothieving is used, it shall meet the criteria in DEC STD 176-0, modified as follows for SMOBC.

The following items shall not be classified as defects on autothieving pads.

1. Poor or no solder coating, nonwetting, or dewetting
2. Burning, roughness, or wrong solder alloy composition

8 ALLOWABLE REPAIRS

Digital personnel and personnel of suppliers not of Digital may perform repairs as specified in *DEC STD 176-1 Printed-Wiring Board Repair Criteria*. After repair, the board must meet all physical, electrical, cosmetic, workmanship, and cleanliness requirements of DEC STD 176-0.

9 PRODUCT SAFETY

The UL requirements for all printed-wiring boards supplied to or made by Digital are specified in DEC STD 176-2.

10 NONCONFORMING BOARDS

All nonconforming PWBs shall be processed in accordance with *A-SP-7665075-00-0, Procedure for Processing Nonconforming Material and In-Process Waiver*.

11 PACKAGING

In addition to good commercial practice in packaging, marking, shipping, and storing, packaging requirements shall be as specified in DEC STD 176-0.

12 QUALITY ASSURANCE TESTS

Unless specified otherwise, the following quality assurance tests in IPC-TM-650 are applicable for the purposes of this standard.

Table 3: Quality Assurance Tests

IPC-TM-650 Subhead	Title
	Dimensional Tests
2.2.7	Hole Size Measurement, Plated
2.2.13	Thickness, Plating in Holes
2.2.13.1	Thickness, Plating in Holes, Micro-ohms Method
	Chemical Tests
2.3.23	Soldermask Cure (Permanency), Thermally Cured Masks
2.3.25	Detection of Ionizable Surface Contamination (Static Method)
2.3.26	Detection of Ionizable Surface Contamination (Dynamic Method)
2.3.27	Resistance to Fluxes (Soldermask)
2.3.28	Resistance to Solvents (Soldermask)
	Mechanical Tests
2.4.1	Adhesion, Plating
2.4.1.1	Adhesion, Marking Paints and Inks
2.4.27.2	Soldermask Abrasion (Pencil Method)
2.4.28	Adhesion, Soldermask
	Electrical Tests
2.5.11	Insulation Resistance, Multilayer Printed Wiring (Within a Layer)

APPENDIX A REFERENCED DOCUMENTS

A.1 Digital Documents, EL-Class

Document Number	Document Title
76-65075-00	*Procedure for Processing Non-Conforming Material and In-Process Waiver*
EL-00016-00	*DEC STD 016-0 Printed-Wiring Board and Module Manufacturing Terminology*
EL-00176-00	*DEC STD 176-0 Printed-Wiring Board Acceptance Criteria*
EL-00176-01	*DEC STD 176-1 Printed-Wiring Board Repair Criteria*
EL-00176-02	*DEC STD 176-2 Printed-Wiring Board Product Safety Criteria*
EL-00176-04	*DEC STD 176-4 Surface Mount Printed-Wiring Board Acceptance Criteria*
EL-MF543-00	*Procedure for Soldermask Evaluation*
EL-SM176-00	*Printed-Wiring Board Manual*

A.2 Documents External to Digital

Document Number	Document Title
A-A-113	*(Formely L-T-90) Tape, Pressure-sensitive Adhesive (Cellophane and Cellulose Acetate)*
ASTM E53-48	*Standard Method for Chemical Analysis of Copper (Electrolytic Determination)*
IPC-S-804	*Solderability Test Methods for Printed Wiring Boards*
IPC-SM-840	*Qualification and Performance of Permanent Polymer Coating (Soldermask) for Class II Printed Wiring Boards*
IPC-TM-650	*Test Methods Manual*
MIL-C-14550	*Copper Plating, Electrodeposited, Class 1*
MIL-G-45204	*Gold Plating, Electrodeposited, Type II, Grade C*
QQ-N-290	*Nickel Plating, Electrodeposited, Class 2*
QQ-S-571	*Solder, Tin Alloy: Tin-Lead Alloy; and Lead Alloy*

A.3 Ordering Information

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Following are the sources for documents not available from Standards and Methods Control.

- American Society for Testing and Materials (ASTM)
  1916 Race Street
  Philadelphia, PA 19103

- The Naval Publications and Forms Center
  5801 Tabor Ave., Philadelphia, PA 19120
  Telephone (215) 697-3321
- Copies of these IPC publications may be purchased from the Institute for Interconnecting and Packaging Electronic Circuits,
  7380 North Lincoln Ave., Lincolnwood IL 60646
  Telephone (708) 677-2850

APPENDIX B RELATED DOCUMENTS

B.1 Digital Documents, EL-Class

Document Number	Document Title
EL-MF299-00	*Printed-Circuit Boards/Modules: Cleaning Process Contamination*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

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